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PROVISIONAL SPECIFICATION

Improvements in the Manufacture of Moulds for Casting Metals

We, WILLIAM JESSOP & SONS LIMITED, a company duly incorporated under the laws of Great Britain, of Brightside Works, Sheffield, and PHILIP HECTOR LAWRENCE, a British Subject of the aforesaid Company's address do hereby declare the nature of this invention to be as follows:—

The present invention is concerned with improvements in or relating to the manufacture of refractory substances and is particularly, though by no means exclusively concerned with the manufacture of refractory moulds for use in the precision casting of metals by what is usually known as the lost-wax process.

Briefly summarised the lost-wax process comprises firstly the production from a master pattern of a metal mould; into the mould molten wax is introduced. After the wax has set it is carefully removed from the mould and trimmed to final shape. The wax model with risers and runners is then placed in a moulding box into which liquids and refractory sands, hereinafter for convenience referred to as investments, are introduced and thereafter the box, after a period to allow of air-drying of the investments is heated somewhat to cause the wax to melt after which the mould thus formed is heated in a furnace to a high temperature in the region of 1150°C. which, of course, is varied according to the size of the mould required and according to the compositions and proportions of the materials used. During furnace treatment the investments become baked hard to yield a clean and smooth-surfaced mould for the subsequent reception of molten metal.

This method of casting has several advantages as for example castings are produced to a marked degree of accuracy and have such smooth surfaces that machining may be eliminated. However, particularly in casting metals or alloys having a relatively high melting point care has to be taken in selecting materials for the investments and hitherto the investments have comprised moulding "sands" of fine grade and a bonding medium comprising silicon esters and hydrochloric acid. The use of such a bonding medium which forms a film of colloidal silicic acid around the particles of the moulding sands is so markedly costly that the advantages of precision casting are almost outweighed by the cost.

It is accordingly one of the various objects of the present invention to provide for the production of refractory substances particularly for use in precision casting in a less costly manner than hitherto.

Broadly, and as will hereinafter appear, a refractory substance is produced by subjecting to a high temperature a suspension of moulding sands in a solution of a metallic salt or salts. By the application of heat the solvent of the salt is driven off and the salt converted into colloidal particles of the oxide of the metal which upon further heating sinter together to form a bonding medium for the sands.

In order that the nature of the invention may become more clear there will now be described a convenient process provided by and illustrative of the invention. This illustrative process relates to the production of moulds or investments for use in the precision casting of metal articles and it is clearly to be understood that it has been selected for description merely by way of exemplification of the invention and not by way of limitation thereof.

As outlined above moulds for use in precision casting are prepared from liquids and refractory sands or investments which after air-drying are subject to high temperature. In the illustrative process the investment comprises a dry mixture of the following, the proportions being given by weight.

Sillimanite F.F. grade	7 parts
Sillimanite 30 mesh grade	28 parts

After the materials of the investment have been throughly mixed they are suspended in a concentrated solution of magnesium sulphate in water and the mass is introduced into a metal container so as to surround a wax pattern maintained therein; the concentration of the magnesium sulphate solution is varied according to the size of the mould and strength required. During introduction of the mass the container is constantly agitated to preclude the formation

of air-bubbles and to ensure a firm and even distribution of the mass in the mould. Surplus liquid on the top of the container is then removed and after a period of some two hours to allow of air-drying the mould is removed from the container and a further period of some twelve hours air-drying is undergone by the mould. Finally the mould is fired in a furnace for a period of at least three hours depending upon its size. The temperature of the furnace is raised gradually from room temperature to about 1150°C. and during the initial heating the wax pattern will melt and run out of the mould. During further heating the magnesium sulphate will first be converted into colloidal magnesium oxide which surround the investments and then the magnesium oxide will sinter together so as firmly to bond the granules of the investment. It will be appreciated that by using magnesium sulphate (a cheap and readily obtainable compound) instead of silicon esters as a bonding medium, the cost of producing refractory moulds will be greatly reduced.

It will also be realised that salts of metals other than magnesium may be used, for example the salts of silicon, calcium or aluminium and that not only sulphate salts but the salts of other acids. For example magnesium carbonate may be used in which case instead of having water as a solvent a dilute solution of hydrochloric acid will serve which upon heating will yield a magnesium base that upon further heating will sinter to give a satisfactory bonding agent.

Dated this 27th day of August, 1945.

S. CLARK,
Chartered Patent Agent.

COMPLETE SPECIFICATION

Improvements in the Manufacture of Moulds for Casting Metals

We, WILLIAM JESSOP & SONS LIMITED, a company duly incorporated under the laws of Great Britain, of Brightside Works, Sheffield, and PHILIP HECTOR LAWRENCE, a British Subject of the aforesaid Company's address do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention is concerned with improvements in or relating to the manufacture of refractory substances and is particularly, though by no means exclusively concerned with the manufacture of refractory moulds for use in the precision casting of metals by what is usually known as the lost-wax process.

Briefly summarised the lost-wax process comprises firstly the production from a master pattern of a metal mould; into the mould molten wax is introduced. After the wax has set it is carefully removed from the mould and trimmed to final shape. The wax model is sprayed with a refractory coating and with risers and runners is then placed in a moulding box into which liquids and refractory sands, hereinafter for convenience referred to as investments, are introduced and thereafter the box, after a period to allow of air-drying of the investments is heated somewhat to cause the wax to melt after which the mould thus formed (the refractory coating of the wax model forming the inner surface thereof) is heated in a furnace to a high temperature in the region of 1150°C. which of course, is varied according to the size of the mould required and according to the compositions and proportions of the materials used. During furnace treatment the investments become baked hard together with the refractory coating to yield a clean and smooth-surfaced mould for the subsequent reception of molten metal. After casting the mould is broken to enable removal of the desired product.

This method of casting has several advantages as for example castings are produced to a marked degree of accuracy and have such smooth surfaces that machining may be eliminated. However, particularly in casting metals or alloys having a relatively high melting point care has to be taken in selecting materials for the investments and hitherto the investments have comprised moulding "sands" of fine grade and a bonding medium comprising silicon esters and hydrochloric acid. The use of such a bonding medium which forms a film of colloidal silicic acid around the particles of the moulding sands is so markedly costly that the advantages of precision casting are almost outweighed by the cost.

It is accordingly one of the various objects of the present invention to provide for the production of refractory substances particularly for use in precision casting in a less costly manner than hitherto.

Broadly, and as will hereinafter appear, a refractory substance is produced by subjecting to a high temperature a suspension of moulding sands in a solution of a salt of magnesium, silicon, calcium or alluminium. By the application of heat the solvent of the salt is driven off and the salt converted into colloidal particles of the oxide of the metal which upon further heating sinter together to form a bonding medium for the sands.

In order that the various objects of the invention together with the several features thereof (which features are set out respectively as the appended claims) may become more clear there will now be described a convenient process provided by and illustrative of the invention. This illustrative process relates to

the production of moulds or investments for use in the precision casting of metal articles and it is clearly to be understood that it has been selected for description merely by way of exemplification of the invention and not by way of limitation thereof.

As outlined above moulds for use in precision casting are prepared from liquids and refractory sands or investments which after air-drying are subject to high temperature. In the illustrative process the investment comprises a dry mixture of the following, the proportions being given by weight.

Sillimanite F.F. grade . 7 parts
Sillimanite 30 mesh grade . 23 parts

After the materials of the investment have been thoroughly mixed they are suspended in a concentrated solution of magnesium sulphate in water and the slurry is introduced into a metal container so as to surround a wax pattern maintained therein; the concentration of the magnesium sulphate solution is varied according to the size of the mould and strength required. During introduction of the mass the container is constantly agitated to preclude the formation of air-bubbles and to ensure a firm and even distribution of the mass in the mould. Surplus liquid on the top of the container is then removed and after a period of some two hours to allow further agitation and air-drying, the mould is removed from the container and a further period of some twelve hours air-drying is undergone by the mould. Finally the mould is fired in a furnace for a period of at least three hours depending upon its size. The temperature of the furnace is raised gradually from room temperature to at least 1000°C. about 1150°C. being actually preferred, and during the initial heating the wax pattern will melt and run out of the mould. During further heating the magnesium sulphate will first be converted into colloidal magnesium oxide which surronds the investments and then the magnesium oxide will sinter together so as firmly to bond the granules of the investment. It will be appreciated that by using magnesium sulphate, (a cheap and readily obtainable compound) instead of silicon esters as a bonding medium, the cost of producing refractory moulds will be greatly reduced.

During the conversion of the salt to the oxide of the metal there may be a tendency for the gases evolved to cause the formation of cracks in the investments. In order to avoid this it is possible to include in the original a quantity of Bentonite which will act as a temporary bond during this time and which will not be detrimental to the final bond obtained.

Instead of magnesium salts, the salts of silicon, calcium or aluminium may be used and in place of sulphates the salts of other acids may be employed. For example magnesium carbonate may be used in which case instead of having water as a liquid vehicle or solvent a dilute solution of hydrochloric acid will serve which upon heating will yield a magnesium base that upon further heating will sinter to give a satisfactory bonding agent.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. A method of forming a refractory mould comprising introducing around a pattern a slurry consisting of finely divided refractory sand and a salt of magnesium, silicon, calcium or aluminium in solution in a liquid vehicle, allowing the slurry to dry and thereafter subjecting the mould thus formed to a temperature in excess of 250°C. during which period the salt will first be converted into the oxide of the metal which thereafter will sinter to form an adhesive bond for the granules of the sand.

2. A method of forming a refractory mould for use in precision casting comprising introducing around a wax pattern a slurry consisting of finely divided sands and a solution of a salt of magnesium, silicon, calcium or aluminium, vibrating said slurry to cause it to compact tightly around the pattern and thereafter firing it in a furnace for a period of at least three hours, the maximum temperature of which furnace is raised during such period to at least 1000°C.

3. A method according to Claim 1 or to Claim 2 wherein the salt is a sulphate.

4. A method according to Claim 3 wherein the salt is magnesium sulphate and the solvent thereof is water.

5. A method according to Claim 1 or to Claim 2 wherein the salt is magnesium carbonate and the solvent thereof is dilute hydrochloric acid.

6. A method according to any of the preceding claims wherein Bentonite is also included in the slurry.

7. A method of forming a refractory mould according to Claim 1 or to Claim 2 when carried out substantially as hereinbefore described.

Dated this 19th day of August, 1946.

NORMAN H. BUCKLEY
Chartered Patent Agent.

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